FINAL REPORT

AEA Grant # 2195294

Interior Region
2008 – 2010

Prepared for:

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June 2010

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ABSN's Mission Is:

To provide building science information, comprehensive public education, advocacy, and hands on training in building and maintaining safe, healthy, energy efficient, durable, and sustainable homes and buildings in rural and urban Alaska

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Village End Use Energy Efficiency Measures Program 2008 – 2010

AEA Grant # 2195294 Administered by Alaska Building Science Network

Final Report - Executive Summary: Interior / South Central Region

- By ABSN Project Managers Geoff Butler and Anna Hilbruner, June, 2010

From April 2008 – April 2010 the following 9 rural Alaska villages received energy efficiency upgrades to community buildings:

Alatna, Allakaket, Arctic Village, Chitina, Fort Yukon, Hughes, Huslia, Steven's Village, Takotna

Total program grant funds: $332,500

The goal of these grant projects is to facilitate energy efficiency upgrades to community buildings that deliver the greatest energy savings with the most rapid payback rate on grant funds. Energy efficient lighting upgrades are the first measures undertaken. ABSN provides project development, coordination, training, technical assistance, materials and logistical support to facilitate these projects. For this grant cycle, to advance technology transfer and provide rural employment and skills training, we partnered directly with 33 rural village entities region-wide and provided lighting retrofit training to approximately 57 local maintenance staff who completed lighting and other energy upgrades in their buildings. Region-wide, 116 community buildings and 14 teacher-housing units operated by rural school districts received energy efficiency improvements.

At the inception of these grants in 2002, original energy audits for these projects estimated light fixture (replacement) at a cost of $355 per fixture. Within this scenario, the 2,120 linear fluorescent light fixtures retrofitted region-wide, alone, would have cost $752,600 to complete. With ABSN's methods, when we deduct materials costs of heating measures (~ $4,000), T5/HO lighting ($14,275) and CFL ($1,680) lighting materials grant-wide, our cost for linear fluorescent retrofits is ~$148 per fixture. During the previous Phase 2 grant period: '07 – '08, ABSN's per fixture retrofit cost was $176. During phases 1 and 2 of these projects: '05 – '08 the average number of fixtures we retrofitted per village in all regions was 185. During Phase 3 for all regions with several villages having a much larger lighting scope, our fixture average went to 341 fixtures /village. With a larger lighting scope per village, and far less budget for other measures, each village's start-up, admin, coordination, and other delivery costs are spread-out through many more fixtures and the per fixture delivery cost was effectively reduced.

ABSN's approach of partnering with local city, tribal governments, village corporations and rural school districts, coupled with the substantial in-kind contributions arising from these partnerships – also facilitated the completion of a much larger lighting scope and allowed us to pursue some additional energy savings measures. ABSN's approach provides skills training and employment for rural maintenance staff at greatly reduced costs compared with original audit estimates for these projects.

Primary Accomplishments of this Grant Region-wide for total budget of $332,500:

- 2,120 linear fluorescent lighting retrofits
- 560 Compact fluorescent light bulb installations
- 6 T5 & HO T8 light fixture upgrades in school gym, multi-purpose and maintenance facilities
- ~ $ 4,000 grant funds spent on additional energy efficiency measures beyond lighting including:
  - Chitina: consultation on heating plant selection and purchase of an EK2 low-mass boiler for the Chitina Village Council.
  - 8 programmable thermostats installed through-out the region
- Acquired $55,351 matching grant resources – extending the capacity of AEA grant funding by 17%

Budget breakdown by village:

The final phase of VEUEEM for the Interior / South Central region had a different budget allocation compared with other grant phases and regions. Previous grants had village budgets figured by averaging total grant funds between the number of villages in a given region. Phase III Interior started with several villages allocated with approximately half of traditional VEUEEM budget amounts with the idea that lighting only would be pursued for scope of work. Additionally, Beaver and Venetie budgets were absorbed into the region-wide Interior / South Central budget because those two villages already had very similar on-going energy efficiency grants from other funding sources. After audits were completed we discovered the villages of Fort Yukon and Allakaket had much larger lighting scopes than a typical village. Fort Yukon being an Interior region hub village had a very large lighting scope of 688 linear fluorescent fixtures to retrofit. To accomplish this and other village expanded lighting scopes, AEA provided additional funds to add to this region's overall budget. For final reporting, to achieve a representative comparison on scope of work accomplished compared with available budgets, we are reporting per village budget allocation proportional to lighting scope in each village. This reporting method provides a close approximation of how budgets were spent by village to achieve more representative savings and payback figures.

Grant funds payback and fuel saving measures

Savings from heating measures and corresponding grant expenditures are not included in payback calculations. Our region-wide payback estimate of 1.80 years on total grant funds includes spending for all lighting and heating measures, but it does not account for any savings from the heating measures. In other words, our payback figures absorb the full cost of fuel savings measures, but do not reflect any savings resulting from them. The heating measures will result in measurable fuel savings, which we currently do not have data to calculate.

Region-Wide Lighting Retrofit Summary

For all linear fluorescent, compact fluorescent bulb and T5 lighting retrofits and installations:

- Pre-retrofit energy use for all lighting: 298 kW
- Post-retrofit energy use for all lighting: 154 kW
- Energy savings from all lighting upgrades: 144 kW
- **Pre-retrofit to post retrofit energy reduction: 48 %**

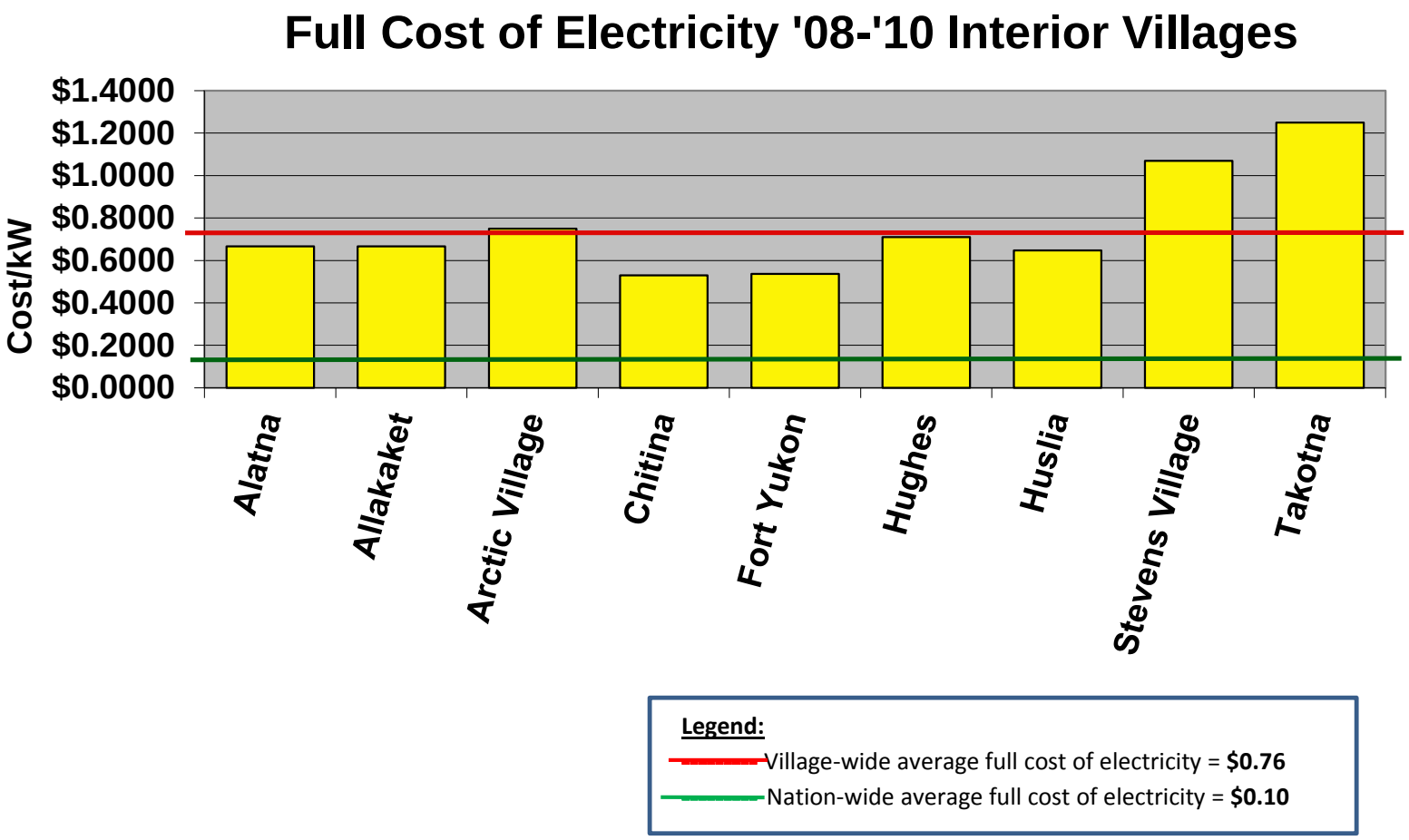
- **Estimated Annual Savings Range:**

Hours Per Day / 250 Days Per Year	Electrical Savings	Avoided Diesel Use (gallons)	Avoided Diesel Costs	Payback Est. (yrs)
4 Hours	$ 90,013	10,527	$ 42,509	3.69
7 Hours	$ 184,955	19,654	$ 10,909	1.80
10 Hours	$ 225,033	26,317	$ 106,272	1.48

- Total grant funds for all energy efficiency measures: $ 332,500
- Simple mean payback (All grant funds, but accounting for lighting savings only) 1.80 Years

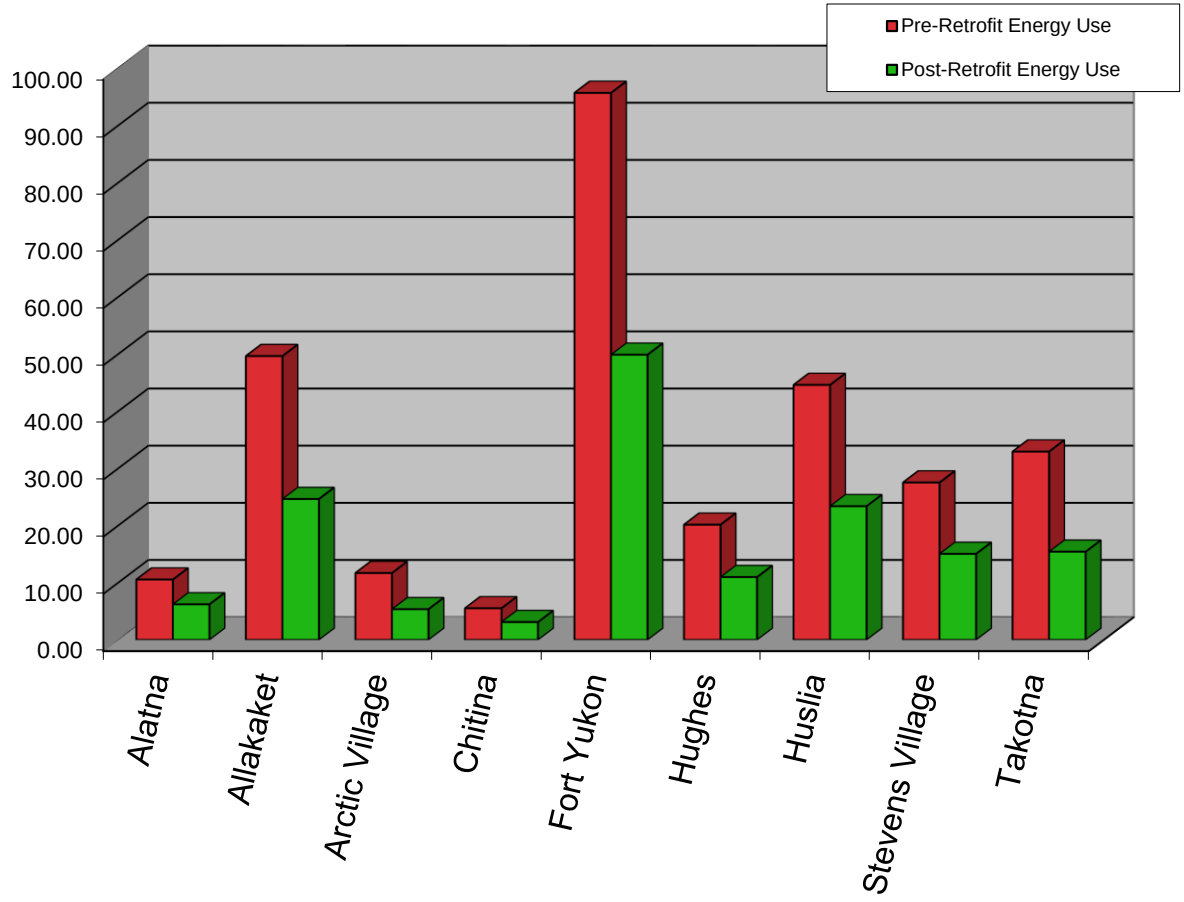
Additional Energy Efficiency Measures (Region-wide grant funding: ~$4,000

After completing lighting measures with good payback, we dedicated remaining grant funds to fuel saving measures and heating system energy efficiency. Our organizational focus in energy efficiency and northern building science places us in the unique position of being able to dovetail similar objectives from different projects providing a win-win benefit to the VEUEEM grants. These and many other in-kind resources enabled us to go beyond the originally conceived scope of work to expand the capacity of these energy efficiency projects. With the larger lighting scope for some villages in this grant phase, and greatly reduced budgets in several villages it follows that available budgets for measures beyond lighting were reduced in comparison with the first four years of the VEUEEM grants.

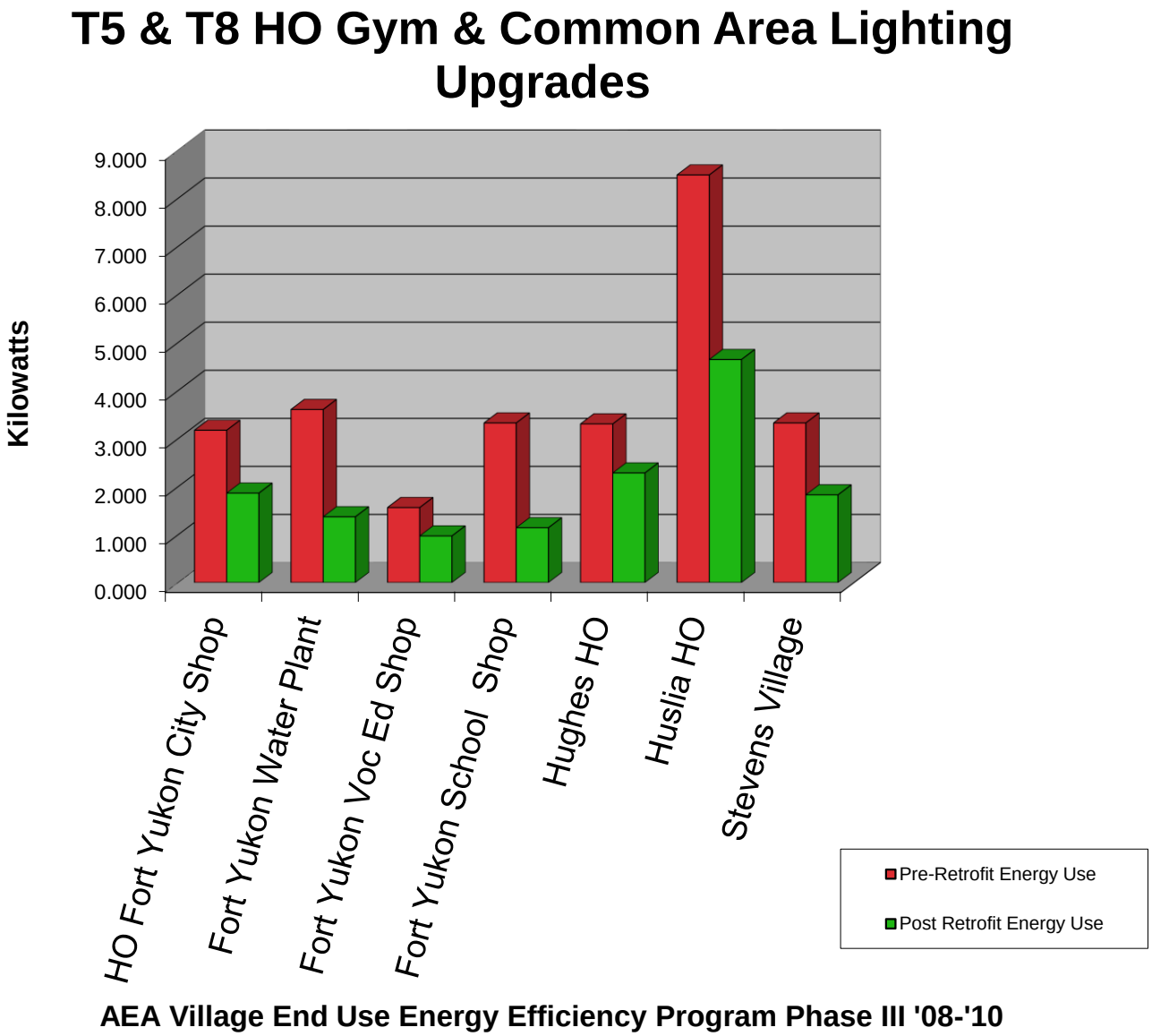


AEA Village End Use Energy Efficiency Progam '08-'10

Lighting Retrofit Energy Savings - Interior Grant



AEA Village End Use Energy Efficiency Program '08-'10



AEA Village End Use Energy Efficiency Program Phase III '08-'10

AEA Village End-Use Energy Efficiency Measures Program – Final Reporting Data For '08 - '10 Interior Grant Activities

With Building Use Estimates of 7 hrs / day, 250 days/year:

VILLAGES	Pre-retrofit Energy Use (watts) (By Grant =Total)	Pre-retrofit Energy Use (KW) (By Grant =Total)	Post-retrofit Energy Use (watts) (By Grant =Total)	Post-retrofit Energy Use (KW) (By Grant =Total)	Percent Wattage Reduction Pre to Post retrofit (By Grant =Total)	Energy Use Savings (watts) (By Grant =Total)	Energy Use Savings (kW) (By Grant =Total)	Lighting / Building Use (hrs/day) (By Grant =Ave)	Lighting / Building Use (days/yr) (By Grant =Ave)
Alatna	10,548	10.55	6,204	6.20	41%	4,344	4.34	**7**	250
Allakaket	49,647	49.65	24,637	24.64	50%	25,010	25.01	**7**	250
Arctic Village	11,686	11.69	5,353	5.35	54%	6,333	6.33	**7**	250
Chitina	5,516	5.52	3,104	3.10	44%	2,412	2.41	**7**	250
Fort Yukon	95,696	95.70	49,881	49.88	48%	45,815	45.82	**7**	250
Hughes	20,144	20.14	10,971	10.97	46%	9,173	9.17	**7**	250
Huslia	44,597	44.60	23,378	23.38	48%	21,219	21.22	**7**	250
Stevens Village	27,527	27.53	15,037	15.04	45%	12,490	12.49	**7**	250
Takotna	32,934	32.93	15,414	15.41	53%	17,520	17.52	**7**	250
Interior Totals/Ave	298,295	298.30	153,979	153.98	48%	144,316	144.32	7	250

AEA Village End-Use Energy Efficiency Measures Program – Final Reporting Data For '08 - '10 Interior Grant Activities

With Building Use Estimates of 7 hrs / day, 250 days/year:

PHASE III - Electric rates are full electrical rates published in the Alaska Energy Authority FY 2009 (July 2008 – June 2009) PCE Statistical Report. Average bulk fuel price data is also from the AEA FY09 PCE report.

VILLAGES	Annual Savings (kWh) (By Grant =Total)	Electricity Cost per kWh (w/out PCE) (By Grant =Ave)	Annual Village-wide savings (dollars) (By Grant =Total)	KW Generated W/ Diesel Per Gallon (kWh/gal) (By Grant =Ave)	Annual Avoided Fuel Oil (gallons) (By Grant =Total)	Diesel Cost per gallon (By Grant =Ave)	Annual Avoided Fuel Costs (dollars) (By Grant =Total)	Total Project Costs: All grant delivery, labor, materials, shipping and, disposal costs	Simple Pay-back (yrs)	# of Rural Entities Worked With	# of Buildings Worked In	# of Teacher Housing Units Worked In	Est. # of Maint. Staff Worked With
PHASE III - Electric Rates are full rates excluding fuel surcharges and excluding PCE deductions. Rates are from the FY 2009 PCE Report. July 1st 2008 - June 30th 2009													
Alatna	7,602	$0.6671	$5,071	13.36	569	$4.98	$2,834	$12,000	2.37	1	3	0	2
Allakaket	43,768	$0.6671	$29,197	13.36	3,276	$4.98	$16,315	$52,000	1.78	3	11	6	11
Arctic Village	11,083	$0.7500	$8,312	12.76	868	$10.00	$8,683	$20,000	2.41	3	9	0	3
Chitina	4,221	$0.5300	$2,237	12.90	327	$3.14	$1,027	$8,000	3.58	2	8	0	2
Fort Yukon	80,176	$0.5363	$42,999	13.63	5,882	$4.45	$26,176	$102,000	2.37	8	40	2	12
Hughes	16,053	$0.7100	$11,397	13.43	1,195	$5.25	$6,275	$20,000	1.75	5	8	0	6
Huslia	37,133	$0.6471	$24,029	13.48	2,755	$4.43	$12,203	$48,000	2.00	5	14	5	10
Stevens Village	21,858	$1.0700	$23,388	10.92	2,002	$5.16	$10,328	$34,500	1.48	2	8	0	5
Takotna	30,660	$1.2500	$38,325	11.03	2,780	$6.14	$17,067	$36,000	0.94	4	15	1	6
Interior Totals/Ave	252,553	$0.76	$184,955	12.76	19,654	$5.39	$100,909	$332,500	1.80	33	116	14	57
	AVE:	$0.76											

	$184,955	Projected Annual Savings (dollars) for 9, '08-'10 - Villages
	$332,550	Total Grant Funds For All 6, '07-'08 Villages
Simple Payback:	**1.80**	years to payback entire grant @ 7 hrs/day & 250 hrs/yr

AEA Village End-Use Energy Efficiency Measures Program – Final Reporting Data For '08 - '10 Interior Grant Activities
With Building Use Estimates of 7 hrs / day, 250 days/year:

VILLAGES	# of 4' Fluorescent light Fixtures Retrofitted	# of CFLS Installed	# of Gym / Multi-purpose Bldgs Upgraded with T5s	T5 & HO (Materials and shipping Cost)	Additional Measures Beyond Lighting (Materials and Labor Cost)	# Programmable T-Stats installed	Total In Kind Contribution from all Village Entities	% Inkind From Total Budget
Alatna	59	3	0	$924			$1,001.44	8%
Allakaket	379	73	0	$2,225		2	$8,029	15%
Arctic Village	88	34	0	$0			$1,485.50	7%
Chitina	37	31	0	$0	$4,000		$568	7%
Fort Yukon	688	231	4	$6,101	$500	2	$20,646	20%
Hughes	134	38	1	$1,051		3	$1,703.00	9%
Huslia	296	71	1	$2,196		1	$5,798	12%
Stevens Village	213	40	1	$1,778			$10,609.78	31%
Takotna	226	39	0	$0			$5,511	15%
NW/SW Totals/Ave.	2120	560	7	$14,275	$4,500	8	$55,351	17%

Lighting Strategy and Savings Estimates

During initial site visits we completed lighting assessments including quantity, locations, and wattage of existing fixtures. From initial assessments and site visits we designed lighting plans and applied various lamp and ballast combinations along with de-lamping strategies to achieve a balance of optimal energy efficiency and ample light levels. From initial assessments and our lighting retrofit plans we determined pre and post energy use by building, village entity, village-wide and region-wide. With a known energy use, we estimated energy and cost savings based on a predicted building and lighting use pattern. Since this information is variable and would require separate grant funds to determine individual building use for these projects, we are reporting our saving estimates based on 250 days / year use and a 3-tier range of 4, 7, and 10 hours/day. (See savings ranges in tables below).

For the purposes of these final reports we focus on a mean lighting use of 7 hours/day. This mid-range use time is selected to average the use pattern of all buildings in our projects. Individual buildings and individual room spaces have a wide range of use patterns. We are confident the actual savings and payback resulting from these projects will fall somewhere within our range of 4 to 10 hours a day. To ground truth our 7-hour/day average run time we sampled run time on lighting with building owners and occupants. These estimates varied largely even for the same building, but local run time estimates generally came in close (on one side or the other) to our 7-hour/day average. For the purposes of these reports we used full electricity rates including fuel surcharges and PCE amounts paid by the State of Alaska. Rates are full electrical rates published in the Alaska Energy Authority FY 2009 (July 2008 – June 2009) PCE Statistical Report. We also used the average bulk fuel price data from the AEA FY09 PCE report.

The Oil Price Factor

With most village power generated through burning diesel fuel, the global price of oil has a profound effect on rural Alaska electricity costs. The VEUEEM grant projects covered in these final reports occurred just after the highest global oil price spike in history. As a result, many villages had to endure the highest fuel and electric costs in their history. In the summer of 2008 the global price of oil spiked at over $150/barrel during the time window when most village entities had to order their bulk fuel for the winter of ’08-‘09. This resulted in extremely high local village fuel costs. With most village power generated through burning diesel fuel, the oil price spike caused a corresponding spike in rural electricity costs through large increases in fuel surcharges. These extreme costs of fuel and electricity in most of rural Alaska lasted through the winter of ’08 –’09, well past when the price of gas and oil related commodities dropped in the rest of road-connected America.

With the price of oil gradually decreasing from the oil price spike in late 2008, and maintaining somewhat lower through the spring and into the summer of 2009, rural utilities were able to purchase their bulk fuel at lower prices compared with 2008. With this, rural costs of electricity for many villages dropped off and stabilized at somewhat lower levels. For comparison, the NW/SW village average electricity cost for Phase 1, ’05-’06 was .39/ kWh. For Phase 2, ’07-’08, NW/SW region during the oil price spike, the average electricity cost was $. 73 / kWh. For Phase 3, over lapping early 2008 through January of 2010, the average cost of electricity for the current nine villages in the Interior / South Central region was $ .76/ kWh.

In this discussion, it should be noted that long-term savings and payback patterns from VEUEEM lighting and other energy efficiency measures will correspond directly with fluctuations in the price of oil, with more rapid payback corresponding with higher oil prices.
Also of note on this topic, the price of village electricity and fuel are not the only elements affected by the global price of oil. The price of many materials and supplies associated with these projects rose considerably with the price of oil. Nearly all grant expenses in purchasing, shipping and travel increased in cost – thereby raising the cost of lighting measures and decreasing the number of measures beyond lighting that could be accomplished within grant budgets when compared to Phase I work completed in 2006.

More on Savings Estimates

When considering savings estimates, it should be noted that for all practical purposes the only thing we can determine accurately is pre and post energy use. When it comes to savings, there are other questions that arise including: The volatile, global price of oil, and who actually sees the savings? If the energy use is reduced in a village, the required operating costs of a village utility must still be met. Utility rates will continue to increase to meet operating costs. Where savings occur, some will be to the State of Alaska in reduced PCE payments, and some will be to the electricity rate-payer. There is also the question of load verses capacity of a given generation system. In some cases where a generation system's capacity is over-extended, dropping the electrical load will be favorable for that utility as they may be spared the costs of generator replacement or overhaul. In other cases, if a system is somewhat oversized for the load already, an additional drop in electrical use may not be favorable to the utility or school. The optimal operating cycle of a given generator will consume a set amount of fuel over time. Reduction in electrical load may not translate directly to how much fuel is burned in a given generator.

Although these factors should be understood, the pressures of high fuel costs, coupled with facts of life in rural Alaska, necessitate the pursuit of energy efficiency programs wherever possible. Also, the trend of improved diesel generation technology, and the ability to tailor power generation levels to match load cycles, means that projects dedicated to overall load reduction are critical. This trend is another practical reason to pursue energy efficiency as an important principle.

We at ABSN continue to be pleased with the results of our work in association with these projects and are happy to be contributing toward energy efficiency cost savings for rural Alaska.

Savings and Payback Projections

Community	Annual Electrical Savings Projections	Total Project Costs	Simple Payback (yrs)
Alatna	$ 5,071	$ 12,000	2.37
Allakaket	$ 29,197	$ 52,000	1.78
Arctic Village	$ 8,312	$ 20,000	2.41
Chitina	$ 2,237	$ 8,000	3.58
Fort Yukon	$ 42,999	$ 102,000	2.37
Hughes	$ 11,397	$ 20,000	1.75
Huslia	$ 24,029	$ 48,000	2.00
Stevens Village	$ 23,388	$ 34,500	1.48
Takotna	$ 38,325	$ 36,000	0.94
Interior Sub Totals	$ 184,955	$ 332,500	1.80

Based on hours of operation: 7 hrs/day for 250 days/year

Savings and Payback Projections

Community	Annual Electrical Savings Projections	Total Project Costs	Simple Payback (yrs)
Alatna	$ 3,390	$ 12,000	3.54
Allakaket	$ 19,518	$ 52,000	2.66
Arctic Village	$ 4,750	$ 20,000	4.21
Chitina	$ 1,411	$ 8,000	5.67
Fort Yukon	$ 20,644	$ 102,000	4.94
Hughes	$ 5,596	$ 20,000	3.57
Huslia	$ 11,161	$ 48,000	4.30
Stevens Village	$ 13,364	$ 34,500	2.58
Takotna	$ 10,179	$ 36,000	3.54
Interior Sub Totals	$ 90,013	$ 332,500	3.69

Based on hours of operation: 4 hrs/day for 250 days/year

Savings and Payback Projections

Community	Annual Electrical Savings Projections	Total Project Costs	Simple Payback (yrs)
Alatna	$ 8,475	$ 12,000	1.42
Allakaket	$ 48,795	$ 52,000	1.07
Arctic Village	$ 11,874	$ 20,000	1.68
Chitina	$ 3,528	$ 8,000	2.27
Fort Yukon	$ 51,611	$ 102,000	1.98
Hughes	$ 13,989	$ 20,000	1.43
Huslia	$ 27,903	$ 48,000	1.72
Stevens Village	$ 33,411	$ 34,500	1.03
Takotna	$ 25,448	$ 36,000	1.41
Interior Sub Totals	$ 225,033	$ 332,500	1.48

Based on hours of operation: 10 hrs/day for 250 days/year

Notes on Budget and Grant Spending

Our objective is to spend grant funds proportionately with scope of work, between villages to the greatest extent possible. To simplify accounting and purchasing large lighting orders are evenly split among villages and among VEUEEM grants. In financial reporting, grant expenditures are noted by village, and by the following budget categories: Field Management, Project Management, Travel Expenses, Materials, and Village Labor.

The total grant amount of $332,500 is divided by the nine villages in proportion to the amount of lighting scope of work in each village. As we get into spending for measures beyond lighting we select projects based on cost-benefit of the least project expense verses the most favorable savings and payback. Additionally projects are selected for measures beyond lighting according to local participation and initiative on the part of village entities to accomplish and enable projects through matching funds for labor or materials. To the degree necessary, village budgets for measures beyond lighting within the region were pooled to cover these measures.

Disposing and Recycling Old Lamps and Ballasts

ABSN's goal is to ensure that all old and unused lamps and ballasts are shipped out of the villages to Anchorage and points in the lower-48 for proper disposal and recycling. In cases where the existing 34-watt T-12 lamps were fairly new, village building owners sometimes prefer to keep the materials and pass them along for continued use. In most cases, lamps are at or near the end of their useful lifespan and are no longer putting out optimum light. All fluorescent lamps contain mercury and as such should not be disposed of in landfills. . As part of '05 – '06 projects, ABSN developed a system of packing and shipping used lamps and old magnetic ballasts from the villages to Total Reclaim Inc. of Anchorage - the largest recycler of fluorescent lamps in the state. From Anchorage the lamps and ballasts travel by container ship to lower 48 recycling facilities. The mercury from lamps is reclaimed, and the ballasts are recycled for their materials.

For shipping used lamps and ballasts from most villages to regional hubs we arranged free back-haul service - generously provided by Ryan Air, formerly: Alaska Transportation Service (ATS). From the hub communities back to Anchorage, Northern Air Cargo provides backhaul at slightly reduced rates as a grant to this program. Used lamps and non-PCB ballasts travel as general freight in properly sealed containers. Used lamps are categorized as non-hazardous universal waste.

Village maintenance staff packing used lamps for recycling

A village shipment of used lamps and ballasts

Bringing used lamps to the air strip

8ft, T-12 lamps prepared for recycling.

8ft lamp recycling container

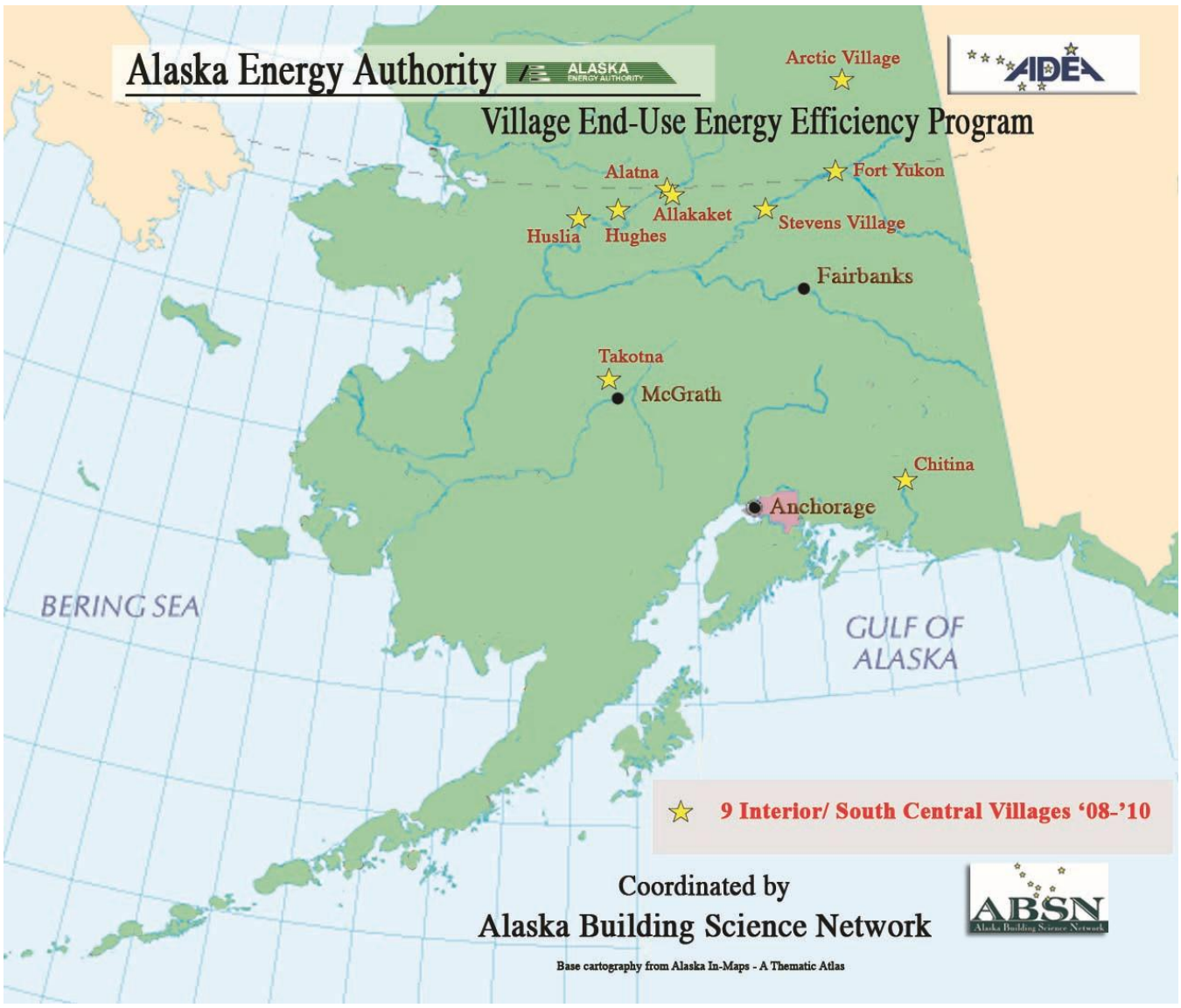
8ft lamps prepared for shipping.

PCB Ballast Disposal

Ballasts manufactured during or before 1979 are considered to contain PCBs, and are classified hazardous waste. In villages where PCB ballasts are found, they must be dealt with under OSHA, EPA, and DOT regulations for proper removal, transportation and disposalAs part of ’05 – ’06 projects, project manager Geoff Butler developed a PCB ballast removal and disposal method for village maintenance staff within EPA and DOT compliance and approved by the Alaska State OSHA office. In cases where PCB ballasts were found, proper removal procedures were facilitated by ABSN. Village building owners and their maintenance staff take responsibility for proper removal - as the generator of the hazardous waste.

Village maintenance staff double checking ballasts for PCBs

DOT approved shipping manifests and haz-mat container of PCB ballasts ready for shipment



The following 9 village reports detail lighting and additional measures undertaken in each of our 2008 – 2010 Interior region villages:

ELECTRONIC APPENDICES

Village End Use Energy Efficiency Measures Program '08 – '10
Interior Region Final Reports

Electronic appendixes associated with these projects are provided as part of our final reports including:

- Cover page and Final Report Executive Summary, file name:
  (**ExecSummary_Cover_Interior_FinalReport_08-10.doc**)

- Regional final reporting summary data, charts and calculations spreadsheets:
  (**Interior_SummaryReportChartData_FinalReport_08-10.doc**)

- Final reports for each village in a folder titled:
  (**Interior_FinalReportsVEUEEM_08-10**)

- Pre-Post retrofit spreadsheets for each village, in a folder titled:
  (**Interior_FinalTalleySheets_08-10**)

- **VEUEEM '08 –'10 ACCESS Database**